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Dr. Ernest H. Volwiler, Hon. AIC, *(right)*
Receiving the AIC Gold Medal from Dr. John H. Nair,
Chairman of the 1960 Medal Award Committee.

(See Page 195)

The CHEMIST

Reg. U. S. Pat. Off.

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Deadlines for THE CHEMIST: For the July issue the deadline is June 15.

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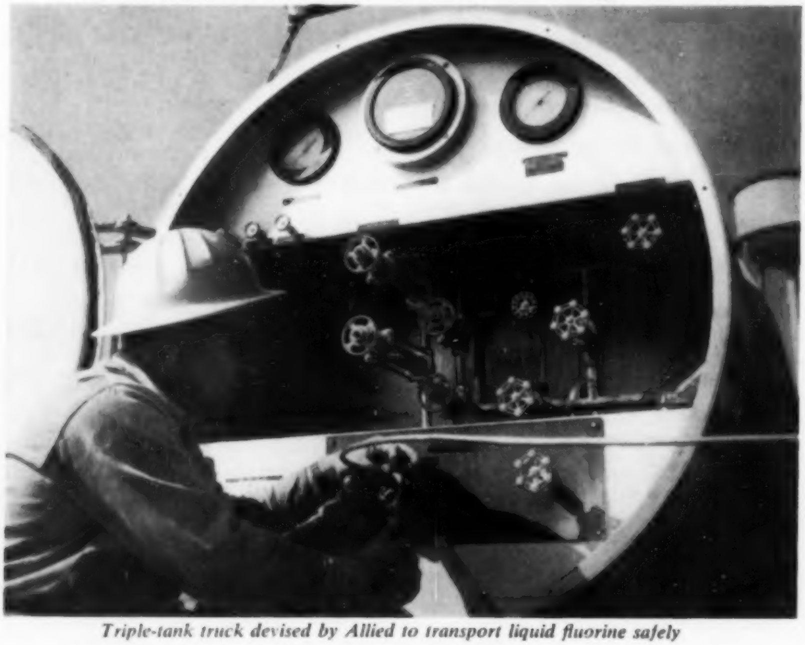
IN THIS ISSUE

Some of the fine papers from the 37th Annual Meeting*

TO COME IN JULY

Prof. Roy G. Francis, professor of sociology, University of Minnesota, is the author of "The Chemist as a Bureaucratically Located Professional"—and in it he also teaches "sociology" to scientists! Dr. Albert L. Elder, F.A.I.C., president of the American Chemical Society, offers "Management and the Young Professional." Both papers were presented at the 37th Annual Meeting. The Report of our retiring president, Dr. Wayne E. Kuhn, and other reports of our active year will be given as space permits. (Departments omitted from the June Chemist will be restored in later issues.)

Recommended Suppliers and Services



Triple-tank truck devised by Allied to transport liquid fluorine safely

EDITORIAL

A Meeting to Remember

Dr. Wayne E. Kuhn, F.A.I.C.

Retiring President, The American Institute of Chemists, Inc.

THOSE who came agreed that it was a meeting to remember—this 37th Annual Meeting, held May 11-13, 1960, at the Radisson Hotel, Minneapolis, Minn. The Twin City Chapter, our gracious host, whose chairman is Dr. Joseph Abere, set a new local attendance record by having 80% of its total membership registered.

Dr. Milton Harris, our incoming president, and Morris Kenigsberg were the chairmen of the Program Committee that supplied an inspiring panel of outstanding speakers on the theme, "The Chemist in an Expanding Universe." Mr. Kenigsberg also admirably handled the many details involved in the position of general chairman of the meeting.

Albert Holler was the chairman of the Committee on Public Relations. With his assistants the press room was constantly covered and releases were supplied on our activities. Michael H. Baker, chairman of the Committee on Arrangements was responsible for the efficient and suitable arrangements. W. W. Benton, chairman of Registration and Finance, conducted the flawless operation of the registration desk. From his experience there, he is preparing recommendations for improved forms that will simplify future registrations. Mrs. John L. Wilson, chairman of the Ladies' Program, was the charming hostess for delightful tours and other events for the ladies.

Souvenirs were supplied by The Toni Company and Economics Laboratories, Inc. Abbott Laboratories sponsored the bountiful reception to our medalist, Dr. Ernest H. Volwiler.

The mood was friendly and intimate; the weather fair; the food excellent. Compliments were spontaneous from those outside of the Twin City area who came to the meeting—some from long distances.

I wish to thank personally and on behalf of THE AMERICAN INSTITUTE OF CHEMISTS each person who served on these Committees or who assisted in making this 37th Annual Meeting such a fine occasion.

The director of student aid and placement of Case Institute of Technology, Cleveland, announces that the 1960 graduating class has received job offers paying an average salary of $525 per month.

Massachusetts Institute of Technology, Cambridge 39, Mass., is offering Special Summer Programs in science, beginning June 14. Request information from MIT.

Special AIC Announcements

Our New Officers

Dr. Milton Harris, vice president, The Gillette Co., Boston, Mass., is our new president. He, as former president-elect, has now succeeded Dr. Wayne E. Kuhn, whose term of office terminated at the 37th Annual Meeting.

Dr. Johan A. Bjorksten, president, Bjorksten Research Foundation, Madison, Wis., and Houston, Texas, was elected president-elect, to succeed Dr. Harris in May 1961.

Dr. Frederick A. Hessel, manager of commercial research, Development Department, General Aniline & Film Corp., New York, N. Y., was re-elected treasurer, and John Kotrady of Texaco Inc., New York, N. Y., was re-elected secretary.

The new councilors-at-large are Dr. Ray P. Dinsmore, vice president research and development, and director, of Goodyear Tire & Rubber Co., Akron, Ohio; Dr. W. E. Hanford, vice president, Olin-Mathieson Chemical Corp., New York, N. Y., and Dr. William J. Sparks, scientific advisor, Esso Research & Engineering Co., Linden, N. J.

About Our Election

About 35 per cent of the AIC membership voted in the recent election of officers and councilors. The nomination ballots were counted by Dr. Lincoln T. Work and Dr. William H. Gardner. The election ballots were tallied by Dr. John L. Hickson and Dr. John A. Steffens. We are grateful to these tellers for their generous donation of time to this task.

Representatives to the Scientific Manpower Commission

Dr. Albert E. Brown and Dr. Donald B. Keyes have been elected as representatives of The American Institute of Chemists by the Scientific Manpower Commission, 1507 M St., N.W., Washington 5, D.C. These representatives attended the meeting of the Scientific Manpower Commission held May 10, and will represent the AIC at future meetings.

Honorary Membership Awards

Dr. John H. Nair, chairman of the Committee on Honorary Membership, announced at the Annual AIC Luncheon, May 13, that the following persons have been selected to receive Honorary AIC Membership sometime during the 1960-61 fiscal year: Dr. Lawrence W. Bass of Arthur D. Little, Inc., Cambridge 42, Mass.; Dr. James W. Perry of the Center of Documentation and Communication Research at Western Reserve University, Cleveland, Ohio, and Dr. Lloyd Van Doren, former AIC Secretary, now retired at Tempe, Arizona.

Dr. C. Harold Fisher to be Honored

Dr. C. Harold Fisher, director, Southern Utilization Research & Development Division, Agricultural Research Service, New Orleans, La., will receive the Honor Scroll Award of the Louisiana AIC Chapter at the annual banquet early in June. He is cited for meritorious service to the profession of chemist as teacher, research scientist, and research administrator.

New Chapter Being Organized

At the National Council Meeting held May 11th, members in North Carolina submitted a petition for a Chapter to be known as the North Carolina Chapter. This petition, obtained by Dr. A. E. A. Hudson, F.A.I.C., was approved, with the request that the members undertake the organization of a Chapter there.

Presentation of the Gold Medal

The AIC Gold Medal for 1960 was presented to Dr. Ernest H. Volwiler, Hon. AIC, chairman of the board of Abbott Laboratories Export Companies, North Chicago, Illinois, at the Medal Award Banquet, held May 12, at the Radisson Hotel, Minneapolis, Minn. Abbott Laboratories sponsored the reception for the medalist.

At the dinner, Dr. Wayne E. Kuhn, retiring AIC president, was toastmaster. Dr. Lloyd H. Reyerson, professor, University of Minnesota, spoke for the medalist. Dr. John H. Nair, consultant, Summit, N. J., and chairman of the Committee on Gold Medal Award, presented the medal to Dr. Volwiler, who responded with an address on "Scientific Waste." (See page 197)

Dr. Volwiler was cited as

> *"outstanding leader in the chemical profession who has striven constantly to promote better cooperation and understanding among chemists and of chemists by the community at large."*

To All Councilors

Meetings of the Board of Directors and the National Council are scheduled to be held on June 21, 1960, with dinner at The Chemists' Club, 52 E. 41st St., New York, N. Y. 6:00 P.M., and on September 11, 1960, (place to be announced) in New York, N. Y.

Alabama Chapter Elects Officers

The officers for 1960-61 of the Alabama Chapter are:

Chairman, Oscar L. Hurtt, Jr., 405 So. 85th St., Birmingham, Ala.

First Vice Chairman, Dr. Charles E. Feazel, Head, Applied Chemistry Div., Southern Research Institute, Birmingham 5, Ala.

Second Vice Chairman, William D. Guthrie, 915 Speake Road, N.W., Huntsville, Ala.

Secretary, Robert E. Lacey, 141 Kenilworth Drive, Birmingham, Ala.

Treasurer, John M. Jernigan, President, Southern Pine Chemicals, 2503 Greensboro Ave., Tuscaloosa, Ala.

Representative to National Council, Martin B. Williams, 1013 Pratt Ave., N.E., Huntsville, Ala.

New Officers for Louisiana Chapter

The Louisiana Chapter has elected the following new officers for the 1960-61 season:

Chairman, Mack F. Stansbury, Program Analyst, Southern Utilization Research & Development Division, USDA, New Orleans, La.

Vice Chairman, Dr. Hans B. Jonassen, Professor, Tulane University, New Orleans, La.

Secretary-Treasurer, Lawrence E. Brown, Southern Utilization Research & Development Division, USDA, New Orleans, La.

National Council Representative, Harold A. Levey, Consultant, 311 Audubon Blvd., New Orleans 15, La.

Professional Appointments

June, 1960. (Day to be announced.) **Minneapolis, Minn.** Meeting of Twin City Chapter. Award of student medals. For information: Dr. Joseph F. Abere, Minn. Mining & Mfg. Co., 2301 Hudson Rd., St. Paul 6, Minn.

June or July, 1960 (Date to be announced). Meeting of Wisconsin Chapter. For information: James E. Henning, 4914 Marathon St., Madison, Wis.

June 2, 1960. Beaver Falls, N. Y. Meeting of Beaver Falls Chapter. Social Hour 6:00 p.m. at Fiber Products Research Center. Dinner 7:00 p.m. at Beaver Inn. Meeting 8:00 p.m. at Community Hall. Speaker: Spencer V. Silverthorne, Jr., Vice President, The J. P. Lewis Co. Subject, "American Military History."

June 7, 1960. Meeting of Niagara Chapter. Student Medal presentations. For information: Dr. Howard W. Post, Chemistry Department, University of Buffalo, Buffalo 14, N. Y.

June 8, 1960, Chicago, Ill., Prudential Building, Beaubien Room. Meeting of Chicago Chapter. Social hour, 6:00 p.m. Dinner 6:30. Business meeting and announcement of new officers. Panel Discussion on "The Social Responsibilities of the Chemist" Participants include Dr. Robert Marshner, Standard Oil Co. of Indiana, on the responsibilities of the chemist to the community, and Dr. Joseph Katz of Argonne National Laboratory, on the responsibilities of the chemist with respect to the effect of his inventions on the country and the world. For information, David W. Young, Sinclair Research Labs., 400 E. Sibley Blvd., Harvey, Ill.

May 11-12, 1961. Washington. D. C. Statler Hotel, 38th Annual AIC Meeting. The Washington Chapter will be our Host.

Scholarships amounting to over $25,000 have been awarded to students at Lowell Technological Institute, Lowell, Mass., for the current year. Many scholarships are still available, according to Dean of Students, Richard W. Ivers, chairman of the scholarship committee.

Airborne Instruments Laboratory, division of Cutler-Hammer, Inc., has moved to Deer Park and Melville, L. I., New York.

Scientific Waste

Dr. Ernest H. Volwiler, Hon. AIC
Chairman of the Board of Abbott Laboratories Export Companies,
North Chicago, Illinois.

(Acceptance address when the author received the Gold Medal of The American Institute of Chemists, May 12, 1960, Minneapolis, Minn.)

LET me assure you that my subject, Scientific Waste, is not concerned with the waste of raw materials or the disposal of wastes from industrial processes—nor does it imply that if one is going to be wasteful, there must be a scientific way of going about it! Rather, I shall discuss the present or potential waste of scientists, of scientific effort, and of scientific results. The world is agreed that power, influence, status, and scale of living for nations as well as for individuals depend upon technologic progress.

Therefore, any waste in scientific effort or results represents a serious loss. This was not such an important problem for earlier generations. Only within the last century has technical progress become such a decisive factor in world decisions, and technical developments hitherto have been confined almost entirely to the western world. It is estimated that today in the U. S., Canada, and Western Europe, about one person of each 200 population is a scientist or engineer.

Sources of Support

To give dimension to our problems, we may recall that the National Science Foundation has estimated that total funds for scientific research and development in the United States in the 1959-60 year will be $12 billion, up $7 billion from the level of 1953-54. During this six-year span, private corporations and related organizations increased their research and development expenditures from $3.6 billion to $9.4 billion in the current year, but more than half of this comes from the Federal Government. Major research and development projects are also carried on within the federal agencies themselves, as the Dep't. of Defense, National Bureau of Standards, the National Institutes of Health, the National Aeronautics and Space Agency, and others.

Of all these funds, it is estimated that about 8% is expended for basic research. This ratio represents our first example of scientific waste. The percentage spent for basic research, nearly everyone agrees, should be larger if we are to avoid the waste of cumulative research and development effort, as well as the waste of some of our best scientific talent. The problem is, who is going to do the higher amount of basic research.

A large part of the Government's expenditures for research and development goes into the military field, and we cannot expect too much basic

research from that source. The National Science Foundation, the National Institutes of Health, the Bureau of Standards, and some other federal agencies are already committed largely to the encouragement and support of basic research. Industry plays its part, but in this area applied research will inevitably get the major part of the available funds.

This then leaves the colleges and universities as our principal continuing sources of fundamental scientific knowledge. But here, too, we run into a problem. According to the National Science Foundation, two-thirds of all recent research and development expenditures in our American institutions of higher learning came from federal grants and contracts; and there is always danger that our educational institutions may be influenced by liberal contracts for applied research development activities to the degree that basic research will receive less than the needed support.

I have used some statistics to suggest that we are being wasteful of scientific support by channeling so much of it into applied research, even in our educational institutions. Fortunately, steps are now being taken by several federal agencies to get more of the funds into basic research, through direct support of men and projects on a longer-term basis, through institutional grants, and by underwriting the costs of special equipment and even laboratories.

Use of Manpower

Another significant possible waste is that of scientific manpower. If a scientist fails to receive adequate support for needed assistance or equipment, or if he works in an unsympathetic or non-understanding atmosphere, or if he is not given reasonable opportunities to exercise his own scientific judgment, then there is a real likelihood of scientific waste. In discussions, mention has also been made of chemists doing jobs which a technician assistant could accomplish, or the writing of needless reports, or carrying out lengthy assignments which made little use of their technical competence.

No one can measure the extent of wasteful practices, and it is easy to either under-rate or exaggerate their importance. Even in science we are mindful of Parkinson's Law, which you will recall is that there is no relation between the work to be done and the size of the staff assigned for its completion; that, on the contrary, work expands so as to fill the time available for its completion; and the subordinates multiply at a fixed rate, regardless of the amount of work produced. You may recall the story told by Yale Coach Herman Hickman about his fishing trip far into the Tennessee hills. At a country store, he asked the cracker barrel gang, "would it be worth my while fishing up here?" The storekeeper removed his pipe, gave the question

great thought, and finally said, "Well, the fishing ain't good, but I don't know how much your time is worth!"

Attitudes of Scientist and Employer

About a year ago the Opinion Research Corporation made a survey of the professional attitudes of scientists and engineers as compared to those of management in six leading scientifically-minded companies, including aircraft, chemicals, drugs, electrical equipment, petroleum, and rubber. The results of this survey were somewhat surprising; certainly they deserve close attention. I have permission from Opinion Research Corporation to refer to the results of this survey.

Two professional groups were studied in each company. They were scientists and engineers as one group, and management as another. The latter group included well educated professionals, many with scientific and engineering backgrounds; almost 4 in 10 had doctorates.

The results indicated a number of frustrations between the two groups. A majority of the scientists and engineers felt that companies forced them to over-specialize, that their talents were misused, and that they were underpaid. The management group felt that scientists and engineers had unrealistic expectations with the desire for status and freedom from work pressures; that they had little understanding of management methods, the nature of risk-taking and decision-making. Each group seemed to lack some respect for the different skills and competences of the other.

Basic to these differences of attitude are the characteristics of each group. The scientific mind is analytical; it wants to investigate all angles in a decision; it tries to postpone risk-taking; its concern is with the theoretical; and its approach is to elaborate and add detail.

The management mind, on the other hand, is integrative; the decisions must often be made on limited information; risks must be taken regularly; practical results are needed; and the approach is to over-simplify.

The survey brought out that over 80% of scientists and engineers regarded themselves as mainly responsible for our high standard of living. No one should quarrel with that; we should not even quarrel if other groups also feel a major responsibility for our standard of living. After all, if a man undervalues himself, who is going to upgrade him properly.

The survey further points out that management lacks readily recognized symbols of professionalism, whereas the scientist has a recognized professional degree, works with tools that symbolize his profession, and has a proud tradition with a long historical background.

Top managers get great satisfac-

tion and psychic reward from being identified and associated with a successful company. Both managers and technical men recognize that scientists and engineers want personal recognition along with, not in place of, monetary compensation.

This Opinion Research project deserves recognition and further study as to how the attitudes of the scientific and engineering and of the management groups may be brought more into harmony. Unresolved frustrations are wasteful of scientists' time and interfere with national goals of accomplishment. Every day managerial decisions—to limit funds, terminate projects — upset the technical man's world. He wants to know why. Scientists and engineers are interested in personal recognition, and evaluation based primarily on technical competence.

It seems to me that this is a two-way street. Management knows that the corporation's success requires a strong productive team of scientists and engineers; the latter group also knows that the facilities and tools for modern technology must generally be provided by corporations with strength and stability which will afford the proper climate in which technological work can be done.

Attracting Future Scientists

Basically our greatest scientific waste occurs in our failure to enlist the interest of young people in scientific careers. Unquestionably, many potentially outstanding scientists never get started in scientific effort because no one has lit the fuse of their interest and enthusiasm. Nor are we alone in feeling this deficiency. Each of the important professions is concerned that it may not attract a sufficient number or ratio of the bright young people in the secondary schools. We feel this loss in the natural sciences, including chemistry, even though in recent years science in the public mind has attained an aura and respect matching those of the other great professions.

Undoubtedly many bright young people are lost to science because their capacities have not been recognized. For this fault all of us, the public, must take the blame. We permit many of our schools to emphasize social qualities and "togetherness" as primary objectives, rather than insisting on intellectual discipline in basic subjects. The child, when he grows up, will need to work in a highly competitive world and he should have the challenge of intellectual competition when he is in school.

It is becoming more and more recognized that many gifted young people—no one knows how many—drop out of school for financial or other reasons and are thus lost to professional activities. Means are now available, through scholarships, grants, and loans to assist qualified students to continue. We can all do our part to supply the encouragement and the

motivation. In a democracy no one is forced into an occupation which he does not understand and in which he, therefore, is disinterested; so each profession must cultivate its own adherents.

It does seem to be a waste of effort to try to estimate how many graduates a field, such as chemistry, can usefully absorb. Scientific talent, like commodities, is subject to the law of supply and demand. Had the training of chemists been artificially limited during the depression '30's when jobs were so hard to get, we might have had dire results when the war broke out, and also in the years since it ended. Chemistry is an increasingly demanding science, and the needs for its services will continue to grow.

Recognition and Satisfaction

As indicated, the remuneration of the chemist lies not alone in the realm of money, important though that is. Much of his satisfaction and stimulus derives from appreciation from his fellow scientists and the public at large. It is gratifying that this appreciation has come to him in greater degree than ever before. In fact, there is perhaps some slight possibility that the public may come to have too great esteem for scientists, believing that they will take care of all major problems that may arise.

Most chemists are employed in industry. The individual is responsible for the ideas and their early exploration. Beyond that, nearly every worthwhile effort will involve the collaboration of many others of the organization. In a successful project, industry generally would like to give the individual chemist the public recognition to which his work entitles him. But how to do it? Several years ago, at the annual dinner of the scientific staff of my Company, attended by several hundred people, those who had actively participated in the research and development of one recently marketed product were asked to rise. About one-fifth of the audience did so. Obviously it is impossible to enlist the interest of the public in the names of such a large group. This points up the importance of the various ways in which industrial corporations are trying to give at least internal recognition to their talented chemists. When it can also be done externally, so much the better.

Another waste of talent may occur when a productive chemist feels that his only opportunity for real progress lies in assuming an administrative post, even though his primary interest lies in personal research. Fortunately, some effective efforts are being made to recognize these outstanding scientists so that their economic and professional status does not suffer in comparison with that of their administrative brethren. More attention needs to be given to this aspect of professional life.

We often hear that the most effective and productive research output

of a scientist comes during the third and fourth decades of life. Undoubtedly there is often truth in this claim, though we can all cite many cases when the value of a scientist's personal work continued to grow throughout his normal active lifetime.

In the chemical field, as in most others, the individual after forty years of age may have a more difficult time in getting a new job commensurate with his abilities. The public also suffers from such waste of a chemist's talents. There is no easy or perfect solution. Various ideas are now being explored, and a solution or at least some practical alleviation may be not at all impossible.

Legal Hurdles

Another phase of scientific waste lies in the government domain. The Federal Government today is the largest source of research and development funds in our country. In spite of its drawbacks, we might as well accept this as a permanent situation, as there is no other source from which such huge support funds can be obtained. It is recognized that the programs and expenditures in general have been capably administered by able federal administrators. The executive and legislative planners have usually asked for and they have in large part accepted the advice of the scientific experts whom they turned to for help in devising their broad objectives.

The scientific community is not at ease, however, about some of the apparently wasteful actions that have been taken or proposed. We were reminded of the effects of the so-called Delaney clause which quite inflexibly restricts the use of chemicals in the production and use of foods. One recalls last year's cranberry episode, when a rigid interpretation brought about the recall of a large crop on the suspicion that a trace of weed-killer residue might cause it to be carcinogenic to humans. More importantly, the use of additives for growth stimulation of animals for food has been threatened, even though there is no convincing evidence that human life is endangered thereby.

Our rising population will require greatly increasing quantities of food, which must be grown on shrinking farm areas. Without the uses of chemicals to promote and protect growth, not only of crops but also of food animals, the cost of our food would rise substantially and we would soon face the problem of inadequate supplies. One wonders whether even the food faddists would be willing to face that eventuality. They would deny the use of chemicals in food production, or even in food packaging, but they ignore the fact that foods are nothing but chemicals themselves.

Certainly scientists must be alert to possibilities of harm from unwar-

ranted uses of additives for the production or preservation of food. It is, however, highly wasteful to restrict or deprive our people of the benefits of science solely on the basis of a law which may be interpreted to shackle scientific judgement. It has been aptly said that waste is the result of control being excessive, not of its being absent.

Selection of Major Fields

Whose responsibility is it to select the major fields of scientific effort to benefit the greatest number of people and at the same time safeguard our future in both the economic and the defense areas? Who should be the statesmen of science, deciding how to get us to where we want to be when we get there? This matter of scientific planning is more critically important now than ever before in terms of economic and military survival. Often it is wasteful to be too specific in objectives, to categorize too much. In government supported research, personal interest or prejudice by our lawmakers or by the public they represent may dictate disproportionate support for a specific health project, or an agricultural program, or a space exploration.

One may question whether our nation or the world will obtain more future gain from our present competition with Russia to put a man on the moon than would be derived from more study, say, of the oceans and what they contain and what lies under them; or how to grow the most productive crops on our limited world area; or how to maintain and improve our health standards.

Crash programs are sometimes necessary in periods of emergency, but they may often be undesirable when they run far ahead of the current state of technology and seriously drain scientific manpower from other critical objectives.

In arriving at these decisions, government will inevitably play a major role. Fortunately the various agencies are making wide use of advisory groups to prevent wastage of scientific effort so far as possible. In the executive branch of the Federal Government good results have come from the appointment of a Science Advisor and a Scientific Advisory Committee; and in the State Department it has been distinctly useful to have a Scientific Advisor, and science attaches in a number of our important foreign legations.

In view of the all-pervasive role that science plays in our lives and welfare, my purpose has been to refer to several areas in which critical waste of scientific effort can and often does occur. James A. Killian recently spoke of the current increase of world population of 50,000,000 annually. Pointing out that the population of the United States may pass 300,000,000 by the turn of the century, Dr. Killian went on to say, "Given a rising standard of living, such a population may require as

much as four times the food, the fiber, and other essential commodities as we now consume."

Obviously, technological progress will play an increasingly important role in making use of our resources. To employ them most effectively the scientists themselves, the educational systems, the industries, and the government agencies must do everything they can to overcome and avoid waste of effort and manpower. A good start has been made in various areas. Much more remains to be done.

As individual chemists, we can do much by maintaining a high degree of professionalism, as advocated by THE AMERICAN INSTITUTE OF CHEMISTS; and by association and identification with those in other walks of life who by education, training, and concern for the public welfare will have a strong voice in determining the direction our nation will go.

International Minerals & Chemical Corporation held a news conference, March 23, in Chicago, Ill., to acquaint the public with prospects and problems facing the fertilizer industry. One objective emphasized at the Customer Advisory Panel meeting was to find ways whereby IMC, as one of the principal suppliers of phosphate and potash to fertilizer manufacturers, could be of greater technical service to the industry, as well as to aid industry in the improvement of management practices. It was pointed out that campaigns against the use of fertilizers, by such groups as organic gardeners and others, has not had any effect on fertilizer use. The past year has seen a 10% increase in fertilizer sales, with no rise in prices, and prospects are for greater applications this year.

Science and Politics

The Hon. Orville L. Freeman
Governor of Minnesota

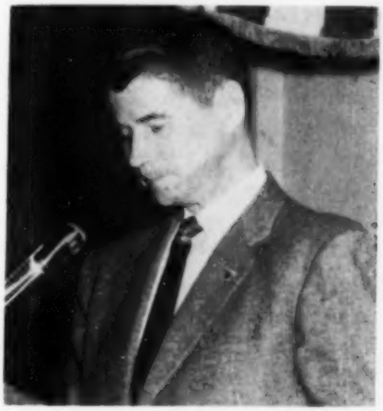
(Presented at the Keynote Luncheon, at the 37th Annual Meeting of The American Institute of Chemists, May 12, 1960, Radisson Hotel, Minneapolis, Minn.)

I WELCOME this opportunity because I believe that, with the increasing interdependence of science and government, there is an accompanying increase in the need for better communication between scientist and citizen.

Any improved avenue of communication between scientist and citizen must be a two-way street. Scientists must convey to laymen, more effectively and more meaningfully than they have yet done; the implications of the scientific explosion that so dominates the current scene. And public officials, representing the citizens, must convey to the scientists an understanding of the problems of our day in terms of human needs, and in terms of programs essential to achieve the kind of human relationships under which we can hope to reap the potential gains, rather than the possible calamities, that can result from our scientific and technological breakthrough.

Improved communication is more critically essential today than ever before, if only because science and politics are more inextricably woven together than ever before. For purposes of illustration I note just a few indications of this inter-relationship.

Those who have studied the history



GOV. FREEMAN

of progress in chemistry in America point out that political conditions were a major factor in its development. When the first world war shattered our dependence on the German chemical industry, our own progress in that field was accelerated more than ever before, until now it represents a $23 billion industry.

A more recent illustration lies in the joining of chemistry with physics and astronomy in attempts to conquer outer space. Ever since Oct. 4, 1957, when the Russians launched earth's first artificial satellite, the general public hears more and more about the progress of science in its attempts to learn the secrets of the entire universe, and to pave the way for man's

further exploration of the stars.

But science, and especially the science of chemistry, is also tied in closely with more earthly matters.

We read that chemistry, joining with biology, physiology, and medicine, may soon help us to conquer mental illness, cancer, and other major causes of human suffering.

We know how much chemistry has done in the field of plastics; how it has helped to transform our technology, our ways of using our natural resources, and how we may hope that it may even help to solve the farm problem by finding new uses for agricultural products.

Any analysis of current social and political problems, ranging from traffic deaths to the hazards of war; from the need for pure water supplies to the changing proportion of aging in our population, finds scientific progress in a major role.

This scientific revolution has come upon us with astounding rapidity. Developments in technology and progress toward plenty are as old as the human race. But their rate of acceleration has increased phenomenally during the present generation.

Let us consider that rate of acceleration by compressing the 50,000 years of man's recorded history into a time span of fifty years. We know very little about the first forty years, although perhaps during the last of that period the most advanced men learned to use skins for clothing. About ten years ago, man emerged from his caves and constructed some other kind of shelter. Five years ago he learned to write. Christianity began less than two years ago. Less than two months ago the steam engine provided a great new source of power. Automobiles and electric power became significant only during this past month. And last week we developed nuclear power!

I am convinced that, revolutionary as the tremendous acceleration in scientific development has been during the past few years, this is merely a prelude to the greater and more far reaching revolution that lies in the years just ahead.

This rapidity of progress is thrilling, but like many thrills, it is dangerous. Its danger lies in our failure to adapt our social, economic and political thinking to the new situation.

Human beings and human society can change, in fact, must change, in adaptation to a changing environment. But social change is, by its very nature, a slower process than changes that are sparked by scientific discoveries.

Einstein referred to this relative slowness just before his death. He was asked why it was that physics had been able to develop weapons of unimaginable destructive power before politics had been able to develop a method of social control over such great power. His answer was simply

— because politics is harder than physics.

I am not sufficiently well acquainted with physics to express a valid judgment as to its relative difficulty as compared with politics; although I am well enough acquainted with politics to know that it is extremely difficult.

But I believe there is another factor that causes the social lag—a factor of utmost importance. Let me illustrate that factor. I suppose that perhaps only a few hundred scientists understood fully what was taking place when the first atomic bombs were dropped at Hiroshima and Nagasaki. I suppose that few, if any, of the scores of thousands that felt the physical effects of those bombs understood anything about nuclear fission. Their lack of understanding made no difference to them.

A chemist can develop a vaccine, or an antibiotic, that can save millions of lives, whether or not those whose lives are saved know a thing about the scientific progress involved.

In other words, scientific progress can result from the brilliant and dedicated work of a few talented people; and its benefits, or its destruction can affect millions of people for better or for worse even though those millions do not know or understand what has been accomplished or what has happened.

But our primary concern today must be to close the gap that exists between our stage of scientific development and our stage of social and political progress. We must learn how to so organize society as to reap the benefits, and not the ills, of the new technology and the new sources of power. It is truly more urgent that we learn how to live together in peace on this earth than it is to learn how to conquer the stars!

This is up to education, to better communication. This is the joint responsibility we face. There is a growing realization of this responsibility on the part of scientists, on the part of leaders in the field of communications, and on the part of politicians. Some of our most brilliant scientists have organized to explore together, not how they may further their own researches in the physical sciences, but how they may awaken the public to the dangers of nuclear war, and how they might influence public affairs to prevent such a war. Some of our greatest scientific leaders have accepted the responsibility to serve on a scientific advisory committee for one of our great political parties.

Incidentally, I have observed a kind of restraint on the part of eminent scientists as they first met, in a working panel, with political leaders —a reserve that seems almost to indicate a sort of suspicion of politicians, a fear lest politicians would exploit the knowledge and prestige of science to some ulterior purpose. And I have

seen this reticence and suspicion dissolve as the scientists came to know that those political leaders with whom they met were honestly seeking knowledge and understanding; that they showed the same respect for truth that is a part of the scientific method; and that they sought cooperation toward common goals.

All of this is of utmost importance. But it isn't enough for just a few leaders to assume responsibility for this tremendous job of communication. Nor is it enough to concentrate only on attempts to avert the danger of a nuclear war.

Therefore, I would like to challenge you to assume a responsibility to help to convey to the laymen, to the non-scientists, to the millions that make up the general public, the real meaning and the real potential of the scientific revolution. I urge that you emphasize, not only the potential danger to civilization that science has created, but also the almost incomprehensible possibilities for a future greater than our fondest dreams.

For science and technology today offer us the greatest opportunity in the history of mankind to build a world of peace and plenty. The tools are at hand. But if we are to grasp this opportunity and make the most of it, millions of people must also see the vision that lies ahead, and millions of people must understand enough about the problems and possibilities to make the right choices.

You, who are in the field of science, can do much to bring to the public an understanding of what this coming age of plenty means. You, who work with the wonders of science, see more easily than does the layman the results of our real breakthrough in the production of power, the possible consequences of the development of automation, the hope now offered by science and technology that, for the first time in the history of man, we can see the possibility of the conquest of hunger and cold and the other physical and natural hazards of life for all men everywhere.

And within the United States this possibility has become almost a reality. We produce so much that we no longer simply produce as a means to the end of supplying needs. Rather we have a billion dollar advertising and public relations industry to persuade us to want more billions of consumer credit to enable us to buy it on easy terms. We have a potential for plenty, and we are failing to take advantage of this potential. Consider the extent to which we are failing.

In the first place, we are not achieving full production, and we are therefore failing to achieve the economic growth we should have. During the years since 1953, our average annual growth rate in national production was only 2.3 per cent. This is only half of the growth rate of be-

tween 4 and 5 per cent that economists believe we should have, if we are to maintain full employment and sustain a rising standard of living for our rapidly increasing population, a rate that we did achieve during the years preceding 1953. It compares with a 9.5 per cent growth rate in the Soviet Union.

This appallingly deficient rate of growth has meant a loss of more than 199 billion dollars in total national production when compared with what an adequately high rate would have produced. It has meant an extra 15 million man-years of unemployment. It has meant over $3,000 less income for the average American family. It has meant a loss of 60 or 65 billion dollars of revenue for federal, state, and local governments that would have been forthcoming at existing tax rates. And this loss of revenue has led to questions as to whether we could "afford" programs that are absolutely essential to national security, and domestic programs that are of crucial importance to our future.

This leads to the second, and perhaps more serious, evidence of our failure to meet the challenge of plenty. We are cursed, not with plenty, but with poverty—in our public services.

Even with our failure to achieve full production, many people would look about them, view the two cars in many garages, note the many gadgets in most households, and say that it seems that we do have a great abundance, it seems we have more than we need, so much more that advertisers must spend billions to get us to use what we do have. There is much truth in the suggestions that many have more than they need—in the field of private goods. But none of us has all he needs in the field of public services.

The Rockefeller Report points out that today the ratio of public works expenditures to the gross national product is only two-thirds as much as it was in the late thirties. Any governor who has tried to formulate a budget, who has listened to the urgent need for services for education, for mental health, for increased public effort to prevent the social ills of crime and delinquency, knows at first hand how deeply serious is our need for public services.

It is in this social imbalance that there lies the most serious danger to our society. And it is this social imbalance that I ask you to help to redress.

Evidence of this social imbalance is all around us. In the years just past, hundreds of millions of dollars have been spent on designing bigger and more conspicuous automobiles, although the ones we had were already too big for our parking spaces and our garages. Yet during those same years, our children suffered for the lack of thousands of new classrooms; and the years of better educational

opportunity that they lost during those years can never be recovered.

It is considered a mark of prestige to build a beautiful home, but it is often considered a mark of reckless spending to keep the street on which the home is built well lighted and well policed.

We willingly pay to private enterprise the price of a good vacation, but we begrudge what we must pay to keep our highways, parks, and lakes up to standard, because these are things we pay for through taxes.

Public services are suffering today in several areas of utmost importance. I have referred to education. We have more children to educate, proportionately, than ever before. Our children need more and better education than ever before. Yet we are frighteningly behind on both facilities and personnel with which to provide that education.

We have more aging citizens than ever before, and we are beginning to learn what their needs and wants are, and how they can live longer, happier and more productive lives. We must learn more, and put that knowledge into practice.

We are rapidly learning more about health, both mental and physical, yet we desperately need more research that would lead to great strides in prevention and cure, and more services that would make the knowledge now at hand available to all.

Our rapidly growing cities and suburbs need public services of all kinds, from sanitation in the newly developing areas to slum clearance and redevelopment in the old sections.

We need more and better trained officials to enforce the law, to work on prevention as well as detection of crime, to provide better probation and parole services.

And for our own security, perhaps our own survival, we need to finance more adequately our preparations for defense and for waging the economic war abroad.

These services are important. They are vital. They can be provided only by government. Yet we are not supporting them adequately. Why are we failing? If these public services are so critically essential to our progress, to our security, and even to the survival of our democratic way of life, why are we failing to provide them. Unless we know the reasons, we cannot intelligently present our case for improvement.

One reason for our failure is that too many of those in positions of leadership are prisoners of the past. They have not yet awakened to the great changes that are taking place. They fear the challenge that these changes present, and in their fear they seek to retreat to the good old days when the old rules and the old techniques prevailed. They try to apply these old rules that developed during centuries of scarcity to the

new age of plenty. They lack the courage and the vision to seek new rules and new techniques to meet the challenge of today.

A part of this retreat to the past is evidenced by the current utilization of the fear of inflation to oppose increased public service. I want to make it perfectly clear that I oppose inflation. I know how regressive it is, that its consequences are most serious for the weaker elements in our economy. But I refuse to fall for the myth that we must choose between inflation on the one hand and adequate expenditures for education and health on the other.

I refuse to accept the fallacy that we must restrict production and accept unemployment in order to avoid inflation. I insist that we must be ready to spend all we need for defense and for foreign aid in order to win the cold war. And if it does come down to a choice, I would rather have a 40-cent dollar than a communist victory.

But I do not think we need make that choice. In 1958 we experienced the amazing spectacle of an increase in the cost of living during a recession. The old tight money techniques have not stopped price increases. Nor did the slump in demand prevent those increases, because they occurred mainly in fields where prices are administered, where prices are privately fixed by means of monopoly control.

We should therefore be prepared to fight any threat of a new kind of inflation in a new age of abundance by methods that will work to stabilize prices but will not impose on us the frightful cost of unemployment, deficient growth, and inadequate public services.

Another major reason for our failure in the field of public services is the current attitude toward government spending and the effect of that attitude on political leaders and elected officials.

Last year there appeared on my desk an appeal by the Chamber of Commerce of one of our large cities to its members—an appeal to exert pressure on Congress to prevent spending. It happened that the expenditures Congress was then considering related to (1) housing, which that city needs; (2) highways, which it also needs; and (3) foreign aid, which is critically needed for security. Housing, transportation, and the defense of our freedom! Our homes, our business and pleasure, our survival! These are all things of great value, essential to our way of life. Why do we subordinate them to private spending for new clothes, new cars, and new gadgets, just because we must buy them through government?

During our last legislative session I tried to secure passage of the withholding method of collecting income tax. This was defeated, and the opposition said it would make it "too

easy" to collect the tax. Now in Minnesota our income tax goes for education. Why should we glorify easy payments and the installment plan for the purchase of gadgets and luxuries, and deny easy payments for the education of our children,

Why should we spend billions to persuade people to buy TV sets and vacations to bring more happiness and pleasure into their lives, and at the same time deny and decry spending that would enable us to prevent and cure the mental illness that causes so much pain and unhappiness?

Why should we spend millions for cars for our teen-agers, and deny the spending for education, for rehabilitation, for slum clearance, and for better correction programs to prevent juvenile delinquency?

Why should I, or any other elected public official, who makes a speech urging the importance of public services for health, education, urban development, and all the other things most people really want, have to run the risk of political opposition and political defeat on the charge of "tax and spend?"

The answer is both simple and complex. People do not realize what their government services provide or what their tax dollars buy. There are, in my opinion, very few parents who would consciously choose a new appliance instead of a good education for their children. There are, in my opinion, very few Americans who would choose lower taxes instead of security against communist victory.

But under our free American system the people must choose. And their choice is being influenced, daily and hourly, by the expenditure of uncounted billions to pay brilliant people to think up new ways to advertise new things and to persuade them to buy more private goods. The people pay for this huge expenditure, and pay willingly, because it is not called taxes.

Who will present the case for public goods and services? It is an obligation of public officials and political leaders to present this case. But they cannot do it alone. I believe that men of science, with their awareness of change, with their recognition of the need for adaptation to change, with their traditional regard for objective search for facts and for the truth, can contribute immeasurably to an understanding on the part of the general public of the problems we face and the potential that lies ahead.

One of your own great leaders in the field of chemistry, James B. Conant (Hon. AIC), has become a powerful influence in our striving for the kind of educational opportunity that this age of science demands. Certainly, in this field of public service, no one can see more clearly than the scientist the need for excellence. I note that *Fortune's* recent article on chemistry reports that among all the chemists interviewed "the consensus

is that the United States has not been developing creative minds in any quantity commensurate with its size, resources, and unparalleled scientific equipment."

Scientists can do much to open our eyes and our minds to possibilities in the field of conservation and utilization of our natural resources. They can help us to find ways to meet the challenge of potential abundance at home, and the challenge of permanent peace in the world.

Then, I believe, we can learn how to live together in a world of peace and opportunity, as well as how to conquer the stars.

A Policy for Small Business

D. H. Jackson, F.A.I.C., vice president, Croll Reynolds, Westfield, N. J., speaking at a recent meeting of the AIChE in Atlanta, said that the rate of corporate failures in the chemical industry is less than for business as a whole. He suggested the following policy to small firms that manufacture chemical engineering equipment:

(1) Concentrate on a few items which cannot be standardized to the point of large mass production.

(2) Be sure salesmen have adequate technical training including a degree, preferably in chemical engineering.

(3) Be sure salesmen have complete knowledge of the product they are selling and its applications.

(4) Keep salesmen in frequent contact with design engineers, test and development personnel, etc.

(5) Train salesmen to give the best possible field service on your equipment.

(6) Train salesmen to "look for trouble" so that they can quickly recognize customer dissatisfaction or malfunction of equipment and meet these problems.

(7) Inspire salesmen to look for new applications of equipment and new modifications that will increase these applications.

(8) Ask customers for suggestions and new ideas they may have for equipment.

(9) Advertise in at least one good technical publication.

(10) Supplement advertising with direct mail sales promotion.

(11) Encourage salesmen and the technical staff to attend meetings of societies and trade associations which cover the field in which the company operates.

(12) Take advantage of the better morale which often exists in small firms and of the absence of "company politics" which is often found in large firms.

Chemistry and the Naval Environment

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(Presented at the First Professional Session at the 37th Annual Meeting of THE AMERICAN INSTITUTE OF CHEMISTS, Minneapolis, Minn., May 12, 1960)

I INTEND to present a broad view of the leading role that research in chemistry is playing in the design and development of the New Navy. I shall also present a few highlights of our research programs in other fields to drive home the point that naval technological progress is catalyzed by the interaction of all fields of scientific research.

Not only does the Office of Naval Research have a chemistry branch, which engages primarily in basic research, but we also have other branches which explore specialized areas touching upon chemistry. These include propulsion chemistry, power sources, metallurgy, biochemistry, solid state physics, upper atmosphere physics, microbiology, oceanography, and hydrobiology. All of these branches must draw from some area of chemical research to carry forward their programs.

In general, chemists are investigating for the Navy various aspects of our needs in the fields of physical, inorganic, and organic chemistry. Basic research in these fields builds up a storehouse of fundamental knowledge which provides new points of departure for solving specific Navy problems. For example, one project is reinvestigating the whole theory of friction and wear which could lead to the development of improved synthetic lubricants designed especially to meet the rigorous requirements of modern warfare. These are required by new naval ordnance equipment, jet aircraft engines and guided missiles.

Basic studies in the chemical and physical properties of liquid metals are contributing to the theory of the liquid state as well as to nuclear reactor technology. Fundamental concepts of surface chemistry can be expected to solve such problems as the adhesion of ice to naval equipment.

Fuels Research

One of our most prominent programs in chemical research, which has been continuing for well over a decade, is the investigation of current and potential fuels for use in rocket, aircraft and marine propulsion engines. This program is a good example of how research is planned and conducted by the Office of Naval Research not only to solve problems that are presently bothering us but also to provide information that will solve problems that do not yet exist.

In 1947, no one could be sure that the Navy would need a long-range ballistic missile and other rocket engines powered by solid chemical fuel. Nevertheless, ONR then instituted a broad program for the development of solid rocket propellants. At the end of World War II the only high energy solid rocket propellant the armed services had was ballistite. However, it tended to change chemically in storage and to disintegrate physically when subject to the wide temperature variations encountered in service use. The solid propellant used in JATO units was more reliable but low in performance and emitted dense clouds of smoke.

An interim program to improve and modify these propellants was carried out, but the Navy decided it needed to conduct research that would lead to a synthetic rocket propellant in the same manner we conducted research to make synthetic rubber. We were confident that this would result in a whole family of high-energy propellants having a wide range of physical and chemical properties. Initial study showed that a self-combustible plastic was needed, and basic chemical knowledge developed after three years of research resulted in the nitropolymers. The advent of a practical POLARIS today has come about because of the research started in 1947.

Again in 1947 the Navy's interest in developing jet engine fuels prompted us to explore the properties of the methyl derivatives of hydrazine. We had to start with fundamental research in the physical structure, heat of combustion and thermodynamic data on these compounds. After four years of research, a compound known as unsymmetrical dimethyl hydrazine or UDMH showed promise as a new high energy fuel. Further laboratory tests and studies conducted from 1950 to 1955 established that UDMH had good stability and ease of ignition even at temperatures as low as —60°F. UDMH was then at the point where the Navy's technical bureaus, other services and industry could exploit it for practical ends. As a result, UDMH was used in the second stage of Vanguard, in the first stages of the Jupiter-C which launched the Army's Explorer satellite, in Bomarc, and in the Thor-Able rocket.

Research on Lubricants

In contrast to research aimed at basic general knowledge, the Navy's special needs often spark research which might otherwise never get accomplished or would be delayed. A case in point is the Navy's special requirements for lubricants. During the Korean War we learned that the automatic aircraft cannon of naval aircraft were freezing up in the frigid cold over North Korea. We had to find a lubricant in a hurry that would keep the guns firing. Borrowing on prior research knowledge, chemists at the Naval Research Laboratory, ONR's major field activity, came up with a stop-gap answer in 90 days. This was a series of synthetic oils and greases that remained effective from —70° to plus 160°F.

With this immediate problem solved, the Navy initiated the long-range task of developing a lubricant which would stay on for long periods and not become contaminated by picking up and retaining dust, dirt, debris and water. We turned to dry-film lubricants as replacement for conventional fluid lubricants. Here we were given a major assist by industrial research. DuPont had developed Teflon, a polymer with superior qualities for heat stability, durability, and corrosion resistance. The Navy through intensive research was able to exploit Teflon's possibilities as a dry lubricant and to ferret out military applications for the material both as a protective coating and as a lubricant. As a result, in a comparatively short time, we were able to solve hundreds of lubrication problems. As a bonus, we also found that this dry lubricant used as a thin film of plastic on metal saved hundreds of pounds of weight and could lubricate surfaces heretofore virtually inaccessible.

Research in Electrochemistry

Turning to more current work, ONR has a research program on the basic electrochemistry which is applicable to fuel cells. Long-lived primary batteries, in which one or more of the active materials are continuously fed into the cell, are an important potential power source for devices, such as torpedoes and submarines, which cannot utilize atmospheric oxygen during their operation. Even though fuel cells have been under investigation since the 1850's, we still have a long way to go. ONR's project is concerned with determining the basic principles of batteries having the electrode-active materials fed into the cell.

Research on Boron

A current research program sponsored by our Propulsion Chemistry Branch is exploring boron. We know that elemental boron's reaction with oxygen yields more heat per unit weight than any other solid element, except beryllium. Therefore, elemental boron has great potential as a solid fuel. However, the fact that a fuel burns with the liberation of great

heat is only a starting point. The key factors are how fast or how efficiently this heat is liberated and whether it is difficult or easy to get the combustion going.

Unfortunately, it is difficult to bring about the combustion of boron. Whereas finely divided aluminum, magnesium, zirconium, silicon and iron, as well as other materials ignite and burn quite readily, dust clouds of finely divided boron in air cannot be ignited with an electric spark under the same conditions. Therefore, our research on boron is inquiring into the basic mechanisms of the combustion of solid elemental boron by doing carefully controlled laboratory experiments.

Organic Research

In the area of organic chemistry we are interested in certain compounds of carbon, which are used extensively in the Navy. They constitute all or important components of many materials, including those of construction, fuels, explosives, propellants, plastics, rubber, coatings, pharmaceuticals, and lubricants.

A current research project is designed to furnish a better theoretical basis for the guidance of workers concerned with producing materials or utilizing organic chemical processes. The improved theory will reduce the amount of time-consuming empirical trial in application research and will provide new concepts and tools leading to new applications and new types of materials. This project includes the conduct of basic research on reactions of major interest to the Navy, such as bond breaking in carbon compounds used in fuels, lubricants, plastics and coatings.

Inorganic Research

Our inorganic chemistry program studies such problems as the structure and reactions of compounds of the lighter elements which are basic to the production and utilization of new materials. One approach we are interested in exploring is the use and extension of synthetic techniques to prepare novel inorganic substances characterized by unusual chemical linkages or valence states. This includes such extreme methods as the application of very high pressures (up to 200,000 atmospheres or higher) at high temperatures (up to 5,000 C.) or high temperatures alone (above 1500 C.) by means of resistance or induction heating, and high temperature excitation by AC or DC electrical arcs and discharges.

Metallurgical Research

In the Navy's metallurgical research program, a major emphasis is on refractory metals which still offer great hope for high temperature purposes. We are encouraged by the significant progress that is being made in the development of protective coatings for these metals. Coatings are urgently needed since the main drawback to using refractory metals in the past is that they turn to powder when

exposed to oxygen in the air at high temperatures.

This is the case with columbium, the most practical metal for achieving temperatures in the 1800° to 2500°F. range. Now, one new Navy-developed coating shows promise of preventing oxidation of alloys of columbium and is capable of automatically healing itself when flaws or defects occur. The coating, which utilizes ordinary grades of zinc as the starting material, was developed by metallurgists at the Naval Research Laboratory.

Applications of the new coating to columbium, as demonstrated in tests at NRL, have shown that columbium alloys can retain their characteristics for long times to meet a wide variety of hardware requirements in the 1600°-2200°F. range while in an environment containing oxygen. The zinc coating has been demonstrated to be compatible with a wide variety of columbium alloys. In this application the zinc is retained on the surface as a zinc-rich alloy of columbium. Upon exposure to air at high temperatures, the zinc is released gradually from this alloy to form a layer of complex zinc-columbium oxide. This serves as an "envelope" which shields the metal from attack by oxygen. When flaws occur, the coating rapidly reestablishes this protective surface over the bare region on the metal surface in a dramatic "self-healing" process.

As I indicated, there are no isolated compartments in naval research. All of our programs are integrated and coordinated toward the achievement of one main objective—the improvement of naval operations. I will cite a few examples of outstanding naval research in other areas, not entirely unrelated to chemistry.

Biological Research

The connection is more readily seen in our work in the biological sciences. This is the research program that enables the Navy to provide the best medical care in the world for its personnel as well as to provide protection for its crews and equipment against injurious or hazardous marine life. For example, the Navy is supporting a program that has opened the door to preserving whole blood for indefinite periods of time so that it can always be available for emergency operations aboard any ship or at any remote base at any time.

Under present-day procedures blood can be preserved for 21 days, after which it becomes unsuitable for transfusion. Several years ago the Navy began sponsorship of the development of a technique using liquid nitrogen, which can freeze blood rapidly to —190°C. At that temperature no natural chemical or physical change takes place in the blood. There is no deterioration or change in the properties of the blood when it is reconstituted and administered to patients.

Two methods for freezing and storing whole blood are under develop-

ment. One has been in use for some time at the Chelsea Naval Hospital where more than 1000 transfusions have been made with blood preserved by freezing with no ill effects. Another method will make possible the freezing of whole blood on a large scale. Development of this system will end the periodic frantic search for blood donors of a certain type and make blood of all types immediately available from stock.

Another current biological research program is exploring the use of anorganic bone or animal bone which has been chemically treated to remove more than 99 per cent of the protein, fat, and other organic materials. Cow bone treated in this manner appears to have advantages over stored human bone as a material used in bone grafts. Anorganic bone is inert for all practical purposes and simply helps the normal forces of the patient's bone to bring about natural repair. One distinct advantage of anorganic bone is that it need not be stored under sterile conditions, as in the case of human bone, but can be made sterile by steam under pressure. Anorganic bone would also be readily accessible in large quantities.

The High Altitude Balloon Program

The Navy is proud of its leadership in the development of high altitude plastic balloons for research in the upper atmosphere. This began in 1946, and Dr. Jean Piccard played a prominent part in the early development work at the University of Minnesota and General Mills.

ONR's high altitude balloon program includes the Skyhook unmanned balloon project, which has obtained scientific data from space at a record altitude of above 150,000 feet, and the Strato-Lab project with human observers. Stemming from this, about two and a half years ago the Navy pioneered in the new field of balloon astronomy, in which balloons, both unmanned and manned, are used to lift telescopes to above 80,000 feet. Since this is above most of the earth's distorting atmosphere, the telescope can view the heavens clearly and make far more detailed and accurate observations of the sun, the planets, and the stars.

In Project Stratoscope an unmanned balloon has carried up a 12-inch telescope in two series of flights to view the sun. After obtaining the sharpest photographs of the sun's structure ever made, the telescope and camera system are safely floated to earth by parachute. Last summer a special television system was added which linked the telescope to the ground. The astronomers on the ground were able to monitor what the telescopes saw on a TV screen and use the TV system to guide and focus the telescope by remote control. This program is helping to prepare the way for launching, in 2-3 years, a satellite equipped with a telescope

and a TV system which will provide us with knowledge of the planets and stars never before possible to obtain. The latest phase of the Stratoscope program is to fly a 36-inch telescope now under construction which will provide unprecedented views of the stars and planets. These techniques are aimed at being ultimately useful for a surveillance satellite system.

By utilizing the Strato-Lab manned system, the Navy is able to send up the astronomer with his telescope, permitting more flexibility in the case of unmanned flights. Last fall two men ascended with a 16-inch telescope mounted atop the gondola to study the planet Venus. They were able to determine for the first time that there is water vapor in the atmosphere of Venus. Although by no means conclusive, this discovery permits the possibility that life exists on Venus.

The Oceanographic Research Program

In contrast, our oceanographic research program has taken us down to the very bottom of the deepest part of the ocean. Here again we are indebted to the Piccard family, specifically to the father and brother of Dr. Jean Piccard, Auguste and Jacques Piccard, who developed the deep-diving bathyscaph TRIESTE. Purchased by the Office of Naval Research from the Piccards, this unique research vehicle has made it possible for Navy scientists to view the ocean bottom and make on-the-spot measurements at depths no man has penetrated before. On Jan. 23, 1960, Jacques Piccard and Lt. Don Walsh of the Navy descended in the bathyscaph to the bottom of the Marianas Trench off Guam, a depth of 35,800 feet. This signifies that there is now no part of the ocean which Navy scientists cannot penetrate to gather fundamental information about the composition and structure of the ocean and its bottom.

Challenged by the new era of space and the atom, the Navy is pressing forward on all fronts to solve scientific problems which a few years ago were not even formulated. Although, we are advancing our knowledge continually, in every scientific field there are major problems which we cannot solve as yet. This is forcing us to use temporary expedients in certain areas and is slowing down our long-range progress.

Problems to Solve

I shall list a few of these problems in the field of chemistry in the hope that some of you may be able to come to our rescue. In the area of rocket propulsion we need propellants with higher specific impulse. This problem is complicated by the fact that we want to avoid high temperatures. Therefore, a concomitant increase in detonability or an increase in the flame temperature is undesirable. Theory tells us that what is indicated is an increase in density and a decrease in molecular weight.

We require high performance, safe explosives which means high detonation energy at low sensitivity. In order to satisfy the requirement for high temperature materials for rocket motors, we need non-brittle materials and materials with greater insulating properties. They must be capable of withstanding high temperature gas flows encountered in rocket motor parts and in high Mach number flow.

We have yet to develop high strength plastic laminates as a competitor to high strength metals. Better fabrication techniques for building laminates, particularly for odd shapes, would help considerably. In the case of batteries, we need better storage life, less variability, and more efficient operation at 0°C. for primary cells. One expert opinion is that Leclanche cells could be improved almost by a factor of two by rigid quality control procedures.

The solutions to these problems cannot be achieved without persistent research, especially basic research. The Navy through the Office of Naval Research supports a substantial amount of basic research at academic and non-profit research institutions throughout the country, but private industry must also do its share. It has been a slow, painful process for industry to come to realize that its future, just as the Navy, depends on basic research. A recent survey of American industry by the National Science Foundation found that the amount of basic research conducted by private industry in 1956 was still very small compared with that of development and of applied research, but it had grown substantially—from $150 million in 1953 to $244 million in 1956.

The chemical industries can be proud of their performance in this area. The survey showed that they ranked first in the dollar magnitude of basic research programs in 1956 as they did the previous survey in 1953. The cost of performance of basic research in the chemical industry was about $55 million in 1956, representing 11% of the industry's total research and development cost, the same proportion as in 1953 and a higher proportion than was found in any other industry.

The Navy, which has been utilizing science since the early 19th century, has long been aware that much of the technology of modern weapons and other military equipment can be directly traced back to research. This was recently confirmed by a special research study conducted for the Naval Research Advisory Committee by Arthur D. Little, Inc. This research on research clearly demonstrated how a major new development owes its existence to new ideas and theories generated sometimes years before through research. This study also makes the point that an organization must participate in basic research itself if it is to reap the full benefits

from what is being performed in basic research elsewhere.

Although I have oriented this paper to the subject of chemistry in the naval environment, it must be obvious that the same information generated to meet the Navy's needs in the area of chemistry has equal application to the needs of industry, and *vice versa*. This is the incentive for the government and industry to cooperate fully in the conduct of scientific research. The job is far too big for either one to handle alone.

In 1906, the Fuller Brush Company began operations in a one room, rented, carriage shed, at Hartford, Conn. In 1960, the company dedicated its $6,500,000 plant covering seven acres at East Hartford, Conn. Board chairman Alfred C. Fuller who started the company with an investment of $375, said that the "new plant is a monument to salesmanship." Sales, now not only of brushes, but of chemical specialties, cosmetics, aerosol products, machine tools, radar parts and air compressors, total more than $100,000,000 a year.

The Pulp Bleaching Conference, sponsored by the Pulp Purification Committee of TAPPI, will be held June 14-16, 1960, at the Edgewater Beach Hotel, Chicago 40, Ill.

The Forest Biology Committee of TAPPI, will hold a special Symposium on Forest Biology, Aug. 24-26, 1960, at the New Washington Hotel, Seattle, Wash.

Chemistry and Life in the Stratosphere and Beyond

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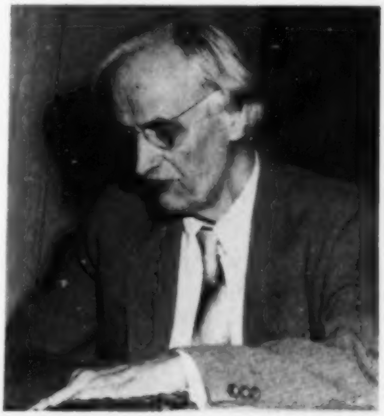
WE might, in order to conform to our title, begin with a short chapter about man in the stratosphere: My brother Auguste introduced, 29 years ago, the stratosphere balloon and the sealed stratosphere cabin. The problem of air regeneration in this cabin was a chemical problem. It is now so well solved that we may omit its description.

As to the composition of the air in the stratosphere: Contrary to earlier beliefs the ratio of oxygen to nitrogen is the same in the stratosphere as in the troposphere. Separation by gravity and molecular diffusion is always annulled by mixing due to turbulence.

As to life in the stratosphere we may say that, save for a few spores blown there accidentally, there is no life in it.

Above the stratosphere we have the "outer space." In the description of outer space all chemistry problems fade away and new physics problems begin. Instead of an atmosphere of molecules we find, as we go up, many broken molecules, atoms and ions. For the space-man going into outer space the respiration problems are the same as they were for the balloonist



in the stratosphere.

There is no question of life in the vacuum of outer space. This question, however, becomes important again when we consider other heavenly bodies.

The first heavenly body we shall meet in outer space is the moon, and this body has no life. That is, I think, a settled question. We know indeed that the moon has no atmosphere except, perhaps, a few atoms of xenon and krypton describing their near parabolic courses in the vicinity of the moon. The temperature on the moon's surface is alternately unbearably high and unbearably low.

The next nearest heavenly body is the planet Mars. There is a good *possibility* of life on Mars. Mars looks decidedly red. We have no spectral analysis of the light reflected from Mars which might be accurate enough to distinguish between the very diffuse spectrum of red iron oxide or the sharper bands caused by organic pigments. Indeed many algae of our own seas have, instead of chlorophyll, a red pigment. If this were the case on Mars, the absorption spectrum of its atmosphere would certainly show that there is oxygen in it. We know indeed, that the solar spectrum, as observed from the earth's surface, has many strong black lines produced by the oxygen of our terrestrial atmosphere. These are the well known Fraunhofer lines. If there is oxygen on Mars, its own atmosphere must produce such Fraunhofer lines. Unfortunately, the Fraunhofer lines of our terrestrial atmosphere are rather strong.

We know on the other hand that the atmosphere on planet Mars, if any, is very thin and its Fraunhofer lines cannot possibly be strong enough to be distinguished from the much stronger earthly Fraunhofer lines as we observe them from any sea level location. The problem could, however, be solved once and for all, if we would photograph the spectrum of Mars, as seen from an altitude of about 20 miles (where we would have about 99% of the earth atmosphere below us.)

Weak terrestrial Fraunhofer lines could still be observed if we, standing on our 20-mile high platform, directed our spectroscope against the moon. Whatever Fraunhofer lines we would still see in its spectrum, we would know without doubt to have been produced by the 1% of earth atmosphere still above us. If, then, we photograph from the same 20-mile high position the spectrum of Mars and if, on this picture, we find dark oxygen lines stronger than those seen in the moon's spectrum we would know definitely that they were produced by the atmosphere of Mars.

This is the reason why we had planned for many years to make a balloon ascent to 20 miles in order to compare the spectrum of Mars with that of the moon. In 1947 we had a Navy contract to build a balloon cluster able to bring us to that altitude. Unfortunately the Navy contract was cancelled about the time of the first successful test inflation of the new plastic balloons. Our plastic balloons are now built by several factories in the Midwest and used largely for instrument flights. Later on, the Navy reintroduced our polyethylene balloons for manned flight. The aluminum cabin which we had built in 1947 has been used several times by Commander Malcolm Ross for important Navy flights.

Commander Ross investigated not the spectrum of Mars but the spec-

trum of Venus. He wanted to find out if there was water on that planet. He found, indeed, the spectral absorption bands of water in the atmosphere of Venus. This was an important discovery. It did not prove that there is life on Venus. The water on earth has not been produced by life. The absence of water would have positively proved the absence of life as we know it on earth. The presence of water proves the possibility of life on Venus. That is one important step forward but it is only a negative argument.

The discovery of oxygen on Mars would have been a positive indication that there is life on the planet Mars. Let us hope that in the not too far future one will observe the spectrum of Mars as seen from 20 miles up and that one will, from the same position and at the same time, observe the spectrum of the moon. The comparison will, if positive, give the answer to the age-old question of life outside the earth. For such an ascent we would use a cluster of about eight plastic balloons, possibly more. We have now at our disposal films much stronger than polyethylene.

Why a cluster of balloons would be lighter (and go higher) than a single balloon of the same total volume is an interesting engineering problem and its answer is rather surprising: Assume that balloons have no excess pressure at their bottom. Then the excess pressure on top will be strictly proportional to the distance between top and bottom. On the other hand the stresses in the fabric of the balloon are at any place also proportional to the radius of curvature. Therefore, the stresses on the zenith are proportional to the square of the diameter. Now let us consider that we use, instead of one large balloon, eight balloons of half diameter each. Then the total volume of the eight small balloons will be equal to the volume of the original large balloon. The area of each small balloon is equal to one-quarter of the area of the orginal large balloon. The needed weight per square inch of the material for the small balloons will be one quarter of the weight per square inch of the material of the original large balloon. Each small balloon weighs, therefore, one-sixteenth of the weight of the large balloon. Since we need only eight small balloons, the weight of the cluster will be one half of the weight of the large balloon which the cluster replaces. We called such an aerostat "The Pleiades." More generally speaking, if we replace one large balloon by *n* smaller ones of the same total volume and the same stress per unit length and unit of thickness of a section, the transformation will divide the needed weight by $\sqrt[3]{n}$ The limit of the possibility of such a transformation is reached when either the calculated film thickness reaches the limit of availability or when the

rate of diffusion becomes a handicap. I have personally made a successful ascent with a pleiade of 98 small balloons.

Now compare Jupiter with the earth and see how different or strange the chemistry of Jupiter is when compared to the chemistry on earth. Hydrogen is in the universe the most common element but oxygen is in the universe a relatively rare element. On earth, as soon as its temperature became low enough to allow chemical compounds to be formed, all oxygen became combined with reducing elements like hydrogen. The earth has lost its excess of free hydrogen in the long period between the earth's formation and the present time because hydrogen is a light element with a molecular speed four times as great as the speed of oxygen molecules. Before this hydrogen was lost into empty space it had plenty of time to combine with all free oxygen, if any, still present on earth. There was no hydrogen left to combine with nitrogen. Then came, apparently, a long time in our history where our planet had neither free oxygen nor free hydrogen. Then, after millions of years, life came to earth and the green plants produced free oxygen. What green vegetation has done on earth, red algae may have done on Mars.

Now let us look more specifically at Jupiter: The surface of this planet is much colder than the surface of the earth, and Jupiter is also much heavier. For these reasons Jupiter was able to keep its hydrogen much easier than the earth. After hydrogen had combined with oxygen, there was enough left to take care of the nitrogen. This is why, I believe, Jupiter has an atmosphere of ammonia. The greenish light of Jupiter (as shown by its spectrum) is produced by an atmosphere of ammonia. Whatever water the big planet may have is frozen solid under oceans of liquid ammonia.

How about life on Jupiter? The low temperature as well as the presence of the corrosive ammonia make life, as we know it on earth, a physical and chemical impossibility. We know, however, that liquid ammonia presents many chemical and physical properties analogous to those of water, more than any other known chemical compound. It is, therefore, not at all impossible that there is on Jupiter, not life as on earth, but a kind of sister life in which ammonia replaces water. It is quite possible that the flying saucers which we saw some years ago were carrying visitors from Jupiter, whose investigation of the earth gave "proof" to them that not only was the earth too hot for life but also, being free of ammonia, could not possibly maintain life. That, then, would be the reason why they never landed on earth!

What we said about Jupiter may also partially be true for planets still further away from us. The outer ones

are too cold for liquid or gaseous ammonia but their spectrum shows the presence of methane. We have been able, with some stretch of the imagination, to assume the possibility of life in liquid ammonia but the assumption of life in liquid methane seems beyond our wildest imagination.

About Venus and Mercury we have little information. The nearness of the sun does not seem to make life on these planets attractive to us. About Venus we have already stated that Commander Ross found some water in her atmosphere.

But let us go beyond the narrow limits of our own little planetary system and ask: "Is there any life on other planets of our galaxy or of any other galaxy?" The answer is simple: "Up to now we have no information."

Some scientists have affirmed that it is unimaginable that among the millions of planets in our universe our little earth should be the only one with life. This mode of thinking neglects the modern science called calculus of probability. If some "international" space traveller would come from outside our galaxy and would discover that the very first planet he meets contains life, he would be justified in assuming that there is life on some other planets too. Imagine we are making the following experiment: Let us take a box with 100 marbles, white ones and black ones in an entirely unknown ratio. Take one marble out blindfolded. Look at it and discover it is a white marble. In this case you are justified in assuming that it is probably not the only white marble in the box because the marble, before you picked it, was not a selected one. Let us assume that we have 100 such boxes, each with 99 black marbles and one white one. Under these conditions it will be probable that if we take one marble at random out of every box we shall, on the average, get one white marble in each batch of 100 marbles taken out. The chances that we find one white marble when we take out just one marble from one box is only 1:100. Now let us look at our imaginary space traveller who came from outside our galaxy, landed at random on one planet, and found life on that unselected planet. He would be justified in saying: "It is unimaginable that this is the only planet which has life." There is indeed a nearly infinite probability that among the millions of other planets of that galaxy there would be many more with life.

But this is not our case. We are born on our planet and we could not have been born on a planet without life. Our case is rather analogous to the following: Here is another box with 100 marbles, all of the same color. All marbles are hollow, have a tiny door and a window. Now take a little lady-bug, and put her at random into one of the marbles. The lady-bug can see the other marbles but cannot

see inside of them. Would the ladybug now be justified in declaring that it would be unimaginable to assume that her marble is the only inhabited one in the whole box? She would be wrong because she, herself, could not possibly be in one of the empty marbles. The same counts for us. The very fact that we are born on this earth makes it a selected planet. We have absolutely no information about the question of life on other planets.

If, however, our exploration would prove to us, by any method of investigation, that there is life on Mars we would be justified in stating: "Since among half a dozen planets of our solar system there are two inhabited ones and since no living being has ever travelled from one planet to the other, it is certain that among a million of other planets a good number are inhabited."

Fortunately there are other methods by which we could at least get a glance at this important question of life on other planets. Let us look at the question: Are animals related to each other? If, for instance, James Cook, in the 18th century, would have found the new continent for which he was looking in the South Sea and if he had found this continent to be populated by a fauna of animals entirely unrelated to known animals, we could assume that they had been created by spontaneous generation or "neobiogenesis." This assumption would be correct if we could prove that the new fauna was indeed entirely unrelated to ours. This is not the case. We find on all continents animals more or less related to each other. It is true that in Australia we find no mammals closely related to our mammals. Australia has indeed nothing above the marsupials except man and such animals which certainly have entered the continent or have been recently imported into it. But the marsupials, though different from other mammals, have so much in common with them that one cannot question their relationship.

The question of relationship of living beings has always been an interesting one. Some 60 years ago, we were told that the vegetable kingdom and the animal kingdom were entirely separated. Even the different classes of animals were supposed to be unrelated. That looked like so many neobiogeneses. Looking at a worm and at a cat we did not see anything common in them, except life itself. (Here the word "we" should probably mean only "high school boys.") This was a natural feeling which corresponds as a whole to the Bible story of creation. Paleontology, biology, and comparative anatomy today, however, show relationships which had escaped earlier observation.

It is interesting to look at the history of the belief in spontaneous generation. Few people realize that there were two entirely different theories about spontaneous generation. Up to

the time of Darwin we find great scientists, like Aristotle or Pascal, who believed that spontaneous generation, not only had started a few times in the gray past, but was a continuous process. Pascal believed that wherever there was a shady old swamp, frogs would appear there by themselves. He believed that wherever there was an old barn with some grain under the floor mice would be produced by spontaneous generation. He even marvelled at the creator producing adult mice with well developed teats when they themselves had never suckled from their mothers.

This notion about neobiogenesis in "the higher echelons" will, if at all, be met today only very rarely. No scientist mentions it anymore. This is due to the spreading of the theory of evolution. If one finds a high mountain lake with trout, one may wonder by what way the fish had come there, but nobody believes that they had been created *"in situ."*

The story about neobiogenesis in the lower echelons is quite a different one. It is today quite generally believed that this was the original beginning of life. There still remain the two important questions: "How?" and "How often?" About the "how" we find an interesting article by John Koesian in *Science,* Feb. 15, 1960. Koesian demonstrates specifically that compounds which might well be called organic compounds in the sense that they could possibly be used for genesis of life in its very lowest echelons (possibly in the laboratory) can now be synthesized *in vitro* by simple catalytic reactions such as one might expect to occur in the oceanic ooze. This looks exciting but if one looks at it closer it is nothing more than a repetition, in another frame of references, of the old experiment of Woehler who synthesized urea (COH_4N_2). These new experiments do not mean creation. Like the Woehler experiment they give a tool which could possibly be used for creation.

Now the second question: "How often?" Here we have the historically important Pasteur experiment. He showed that ordinary broth, if properly sterilized and kept in a well closed test tube, will never show signs of new life. From this, one has tried to deduce that neobiogenesis (which doubtlessly had happened once at the beginning of organic life) can never happen *in vitro,* or more generally speaking, can never happen again. It is true that there is a growing conviction that man will never have a chance to witness neobiogenesis *in vitro.* How wrong would it be, however, to read into the Pasteur experiment a law of nature that neobiogenesis is impossible! The fallacy of such a conclusion becomes evident if one compares the volume of one Pasteur test tube with the volume of the oceanic ooze in which life is supposed to have started. Assuming for the oceanic ooze a thick-

ness of one meter, one finds the volume of the ooze to be roughly 3×10^{19} times greater than the volume of one Pasteur test tube. If we had in the oceanic ooze, one neobiogenesis in one million years we should, assuming the same rate per volume, expect one neobiogenesis in a Pasteur test tube every 3×10^{25} years. Even if we want to assume in the oceanic ooze 1000 neobiogeneses every second (instead of one in a million years) we would still have to wait a billion years to observe even one neobiogenesis in our test tube. All this demonstrates that it is absurd to say that Pasteur has given proof that neobiogenesis cannot occur. He certainly never claimed this himself.

One, although faulty, argument favoring the belief in repeated neobiogenesis is that one finds it difficult to assume that our ancestors have evolved from worms while in the same length of time the worm has not evolved at all. This argument is faulty, because laboratory observations show us that each time a mutation occurs, the unmutated individuals do not die out. For each specimen of the higher evolution there are a great many unchanged individuals left behind. Their descendants may again, perhaps in many years, produce a new mutation but each time this occurs, the unchanged individuals go on reproducing in great numbers. The worm we see crawling around today is not our ancestor, he is a distant cousin, a "poor relative." The same counts for men: Each time a human appeared with another skin color, the older races went on living and propagating.

The same could be shown about uranium: Radium and many other radioactive elements are its descendants. We find them in minerals near uranium. For each one of these radioactive elements, uranium was their ancestor. However, none of these individual ancestors is still alive. Any unchanged uranium atom of today is not the ancestor of the living radioactive atoms, it is their "uncle." If someone would say that it is unimaginable that these uranium atoms are still unchanged after so many thousands of years during which the evolution from uranium into today's radioactive elements occurred, he would be just as wrong as the man who says that the worm we see today could not possibly be the unaltered worm from which we descend.

One has attacked the problem from still another, very hopeful looking angle: Do today's living beings in their chemical make-up have anything of sufficient importance in common to establish relationship?

If one could prove that there are at least several classes of living beings which are undoubtedly unrelated, our problem would be solved. We could then hardly assume that neobiogenesis occurred several times on our single small planet but never on any other

planet and the conclusion would be clear: There is life on some other planets, if not on our own local planetary system at least on some further away planets with similar living conditions. If, however, one could prove that all living matter on earth is related it would mean that, apparently, there was only one original successful creation of life on earth. Then we could say that certainly there are many other planets where the phenomenon never occurred but not that it ever occurred on any other planet. The question of life or no life on other planets would, perhaps, forever remain a mystery.

In opposition to the old belief that the several classes of living animals are unrelated, the modern investigation points more and more in the other direction: As we shall see, closer examination detects more similarities than dissimilarities: Koesian pointed to a consistent similarity among organic compounds found in nature. This similarity stands in opposition to the consistent dissimilarity we found among chemically identical organic molecules synthesized *in vitro*. The organic compounds found in living matter have the similarity that if they are optically active they are always of the same activity (either R or L) while the ones made *in vitro* are always racemic mixtures.

One often states that dead nature cannot synthesize any optically active matter. This is not entirely correct: Look around in a quarry till you find a quartz crystal. It will invariably (unless a twin formation) be of either the R form or the L form but if you look around long enough you will always find both in about equal quantities. The first microcrystal formed was either R or L and it directed the further incoming SiO_2 molecules joining the crystal to place themselves in the lattice in the same form (either R or L, as it was itself). In a similar way we should assume that life started on a very small scale. Assume that the first compound formed was one which, if formed *in vitro,* would be racemic. In this case it is an absolute certainty that the first single molecule formed was not racemic but optically active. In the test tube the following molecules produced would again have an equal chance to be of the R or the L form. This, however, is not the way nature worked. The second molecule formed was not formed independently from the first one. We must assume that organic matter in this first period of neobiogenesis reproduced *itself* and then it follows necessarily that the second molecule was an optically active molecule (laboratory experiments show indeed that an active molecule does engender another active molecule). If we take organic chemistry as it is, we see nothing surprising that living matter produces optically active compounds while laboratory chemistry can produce only racemic mixtures.

This brings us to an important consideration: in all nature we find a single kind of glucose, the D form, which rotates the polarized light to the right while fructose invariably rotates it to the left. This is certainly a strong indication that neobiogenesis occurred only once. There would be no reason why a compound when being created a second or a third time by neobiogenesis should always be of the same form as the one existing anywhere else in nature.

While all this looks at first glance as producing a binding conclusion (singularity of neobiogenesis) it would be unfair not to state that some research men consider the possibility of what they call "symbiotic" compounds. It is quite evident that if today, suddenly, one brought into a laboratory a living rat in whose body all optically active chemicals were of the "unnatural form" this rat, although perfectly happy and well for a few hours would be unable to digest and assimilate normal food. The nonexistence of such a rat would, therefore, one says, not be an argument against repeated neobiogenesis. The "other form," one says, could regularly have died out for lack of proper food. To this, again, we can object: When, before there was optically active food all around, a second biogenesis with molecules being mirror images of the first one had occurred far away from other life, the new life could well have started its own colony.

It is also quite evident that at the beginning of life on earth the living beings were neither vegetarians nor carnivorous and would not have been bothered by the fact that other living beings had not their kind of optical activity.

Apart from the question of optical activity the astonishing similarity of the detailed configuration of many building stones of complicated organic compounds like chlorophyll in plants and hemoglobin in animals is certainly also a strong argument against repeated neobiogenesis.

Conclusion

We have not the slightest indication that neobiogenesis on earth occurred more than once. Any valid proof that a second neobiogenesis ever occurred would alter our whole concept of life. We would then have to assume that other planets too have experienced neobiogenesis at least from time to time.

Now we stand on firm ground when we say that we could prove the likelihood of life on other far distant planets only in three ways:

(1) Go there and find life, or

(2) Find proof of repeated neobiogenesis on earth, or

(3) Establish, as has lately been suggested by Edwin Diamond (*Newsweek*, Feb. 22, 1960), radiocontact or some other kind of contact with intelligent beings on those distant planets.

The finding of oxygen on Mars would not quite fit into the second

"way" but it would come nearer to it than anything else has done up to now.

We have considered life in its earliest occurrences and through the ages of evolution to modern times. We have started this paper with "life on earth"; we have gone through "Chemistry in the Stratosphere." We have considered other planets of our own solar system and of far away galaxies. We have reached the limits of the universe. We can go no further.

Following Dr. Jean Piccard's talk, Dr. Jeannette (Mrs. Jean) Piccard showed a film of a notable, manned balloon ascent made in 1934.

About AIC Members

The University of Pennsylvania dedicated its new $1,500,000 chemistry laboratory, March 9, using a chemical and electrical circuit to set fire to the ribbon across the doorway of the laboratory. The electrical circuit which fired the ribbon was completed when a crystal of silver, being grown in the laboratory, attained the proper size. **Dr. Charles C. Price,** F.A.I.C., chairman of the Chemistry Department, and **Dr. W. A. LaLande, Jr.,** F.A.I.C., vice president of Pennsalt Chemicals Corp., took part in the ceremonies.

Dr. C. A. Johnson, F.A.I.C., associate professor of biological chemistry, University of Illinois, College of Medicine, formerly chairman of the Chicago AIC Chapter, recently attended N. Y. Academy of Science Conferences in New York, N. Y.

Dr. Rudolph Seiden, F.A.I.C., vice president for pharmaceutical production and research, Haver-Lockhart Labs., Kansas City, Mo., and former chairman of the Midwest AIC Chapter, is the author of *Veterinary Drugs in Current Use,* a pocket-size dictionary of 600 drugs, just published by Springer Publishing Co., N.Y. 10, N.Y.

The Key Element - - Individual Responsibility

E. E. Fogle

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(Presented at the Third Professional Session at the 37th Annual Meeting of THE AMERICAN INSTITUTE OF CHEMISTS, Minneapolis, Minn., May 13, 1960)

NO group of which I am aware has made a greater contribution to our country's defense and the general welfare than our chemists. It has been my privilege to know a great many chemists and chemical engineers over the past thirty years and I have always been impressed by their dedication to the scientific discipline. It goes without saying—without that dedication our industry and the service upon which it rests could not have developed to its present size and importance.

The role of the individual in any joint effort or organization has long interested me. I would not expect to be able to do more than raise some questions, which have been posed many times before—nor shall I be able to present the complete answers to the questions raised. The answering is for each of us as individuals. The questions are important and the mere reciting of them has the value of emphasis by reiteration.

For some time, I have found myself puzzling over certain problems and ramifications of the relationship of man and modern society—or more particularly, man as an individual versus man as a group.

E. E. FOGLE

To say that this is a broad area is something of an understatement. After all, everything that man does or conceives of doing must be done by the individual or by the group. Therefore, I shall try to be specific at the outset. The particular aspect to which I will limit my comments is the attitudes and actions of the individual as a member of an ever-enlarging group—his attitudes and actions in the matter of personal responsibility.

I have become concerned about the widely held belief that, as society grows, as businesses become larger, as universities increase in size, that with this growth the individual inevitably

must more and more lose his identity, be absorbed, blended and strait-jacketed into a featureless element of the group.

I have become concerned about the degree to which many individuals accept this loss of identity in a group, and of the prevalent attitude that the larger the group, the less the responsibility of the individual.

That an ultimate, nearly complete loss of identity is foreordained, is accepted as fact—calmly by many, despairingly by some, angrily by a handful—I have no doubt that it is the fear of final, total conformity, the death of man as an individual, that is the genesis of such would-be advance-guard groups as the "beat generation." We decry the ridiculous antics of its members and their attempts to achieve individualism and recognition. We scorn their negative, intellectually blind attempts to be different—not better, not bigger, not stronger—only different. But equally, we must feel great pity and be deeply disquieted that fellow human beings, in such numbers, should be driven by feelings little short of desperation to this course of action.

But the apparent reasons for these actions and these actions themselves, however deplorable, are relatively superficial. Relative to what? To the fact that the basic action taken is a total rejection of personal responsibility to society.

Now, to be sure, this is a rather drastic example, this beat generation, to mention to such a distinguished group as the members of the AIC. It carries some of the inappropriateness of revealing one's favorite recipe for beef Stroganoff before a meeting of vegetarians.

But this is not the case. There are evident in other areas and levels of society courses of action that are all too similar. Based on a fear of loss of identity in a group, or the inability to express individualism adequately, the group and responsibility to that group are rejected. The individual does not seek to divorce himself from a group, *per se,* but to join another group, within which, somehow, he can maintain and demonstrate his individuality—and be applauded and admired for his individual qualities. A group which, at the same time, will protect him and give him stature by some magical means—stature beyond that which he is individually capable of reaching, but one which he believes he richly deserves.

As a business man, I am concerned when I see a man achieving in his job an output only half of which he is capable. My concern is increased when I see him display frenetic energy on the golf course or in some other non-job activity.

I hasten to disclaim the attributes of a martinet. No one should be denied the refreshing joys of participating in a variety of activities. If that is what a man seeks, all is well.

If he desires to discharge his duties as a citizen by taking active part in civic affairs, that is well. But if he is *driven* to other activities, consciously or instinctively, to achieve recognition by the display of his abilities to other groups—or to seek the comfort or shelter or safety not afforded by his chief activity, then something is decidedly wrong. It may be an indictment of the man or of his associates, or of the system or organization of the group in which he works.

Man is not fundamentally lazy or stupid. As an individual he desires to succeed, to excel; above all, he desires the approbation of his peers. He *must* be a member of a group in order to accomplish these objectives, and he *wants* to be a member of a group for security and to share in the rewards sought by the group. The balance between the desire to act as an individual and to act as a member of a group is a valid measure of a man. Too much of the first, and unless he be a genius, he is accepted by none. Too much of the latter, and he becomes a parasite, giving nothing, subtracting from all.

This would seem to be the core of the problem: When to act as an individual—when to act as a member of a group. But there are basic questions to be resolved. Just what does "acting as a member of a group" mean? Can an individual really act as a member of a group? An individual can act or speak for a group. A group can pool the resources of individuals, financial or mental, and accomplish great deeds, but in each case individual contribution is necessary.

Group action is really nothing but the concerted actions of individuals. Non-action by the member of a group produces as little result as non-action by an individual—it is only slightly less evident in the first case. The irresponsibility is identical.

It might appear that I am opposed to the existence of any large group and probably more than a little suspicious of any conclave of two or more individuals. This is not the case. It requires no extraordinary level of perception to realize that modern civilization could not exist in anything like its present form without a high degree of organization.

No, it is not the organization, or the group as such, to which I would lay siege, but to the sins committed in the name of organization, to the philosophy that the individual absolve himself or is absolved of responsibility by membership in the organization, and to the notion that the organization, the entity itself, rather than the individuals comprising it, conceive anything, accomplish anything, and in particular, bear responsibility for anything.

It transcends the obvious to point out that the organization is but a framework within which individuals

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through unified effort strive for a specific goal.

As we increase in number upon the face of the earth, necessarily our organizations—schools, businesses, societies—all grow larger. Prior to the Industrial Revolution, businesses typically were small. Each was operated by an individual, or perhaps partners, who personally directed the work of every employee. Each had responsibilities that he discharged, ably or poorly. But, however well he performed, he performed as an individual. Whatever his fears or joys, his wants or his goals, he was not distressed by any sense of loss of individualism. Under the stern eye of the proprietor he perhaps would have welcomed the anonymity of a group.

Your own AIC was few in numbers 37 years ago. In these early days of its founding, each member must have personally known all others. Individual actions, accomplishments, goals and thoughts were evident. Leadership could be direct, no complex organizational structure was needed for operation, planning was simple. Much responsibility was carried by each individual.

There is no need to add to these examples. The point is obvious. The member of a small group feels no loss of identity as an individual. He cannot lose himself within the group; his successes and failures are immediately recognized; he cannot, if he would, sit back and let the group carry him in the direction of its goal. Therefore, he has a well developed sense of personal responsibility, ample opportunity to exercise it is provided. On the other hand, any tendency to laxness is more easily self-suppressed by the prodding knowledge of certain exposure.

In our large groups of today, quite the opposite is true. The individual can feel a loss of identity, he can lose himself within a group, he can take, at least for a time, a free ride, and he can be frustrated in his attempts to carry responsibilities of which he is capable.

But, enough of the problems. Where is the solution? I believe it to be relatively simple. It is this: Stop comparing, praising, complaining about, dealing with, belonging to or thinking about—groups. Substitute people, substitute individuals—warm-blooded, living individuals who are capable of great acts of accomplishment.

I cheerfully confess that this is in part a matter of semantics. But as our language is a result of our thoughts, just so is much of our thought and human behaviour influenced by the words used and heard. Too, I confess that we cannot rid the language of words designating groups. But when we use these convenient words: divisions, departments, groups, teams and all the rest—let us let the thought rise slightly above the subconscious level, that these are departments of

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people, teams of individuals.

My conviction is strong that the preoccupation with groups — the group attack, the team approach, the brain-storming sessions—and the attendant de-emphasis of the individual has a stultifying influence on our progress. As we work together in ever-increasing number, we must direct our activities, we must work in concert, we must work cooperatively—we must, if you will, make a team approach. But let us glorify the individual as a member of the team, not sublimate him by impersonal evaluation of the team.

It is the failure to recognize the proper relationship between the individual and the group that often jeopardizes the value of that perfectly fine tool, the committee, and brings it to ridicule. Undoubtedly, most of us have been members of many committees, some successful and some not, and we find a somewhat bitter touch of humor in jests directed at them. You have heard them: Definition: The Committee, a group of incompetents doing the unnecessary. The best committee is one of three members with two absent, etc.

When we look at the meager results sometimes accomplished by seemingly great joint effort, it appears that these jests may be more than jests. But it is not the members of the committees that are incompetent so much as the way these committees are operated. In the unsuccessful committee the team approach is at its best, or worst. With no specific delegation of responsibility to its individual members, but with great resolution that the committee shall work as a unit, with team spirit, all pulling together, the thought of anything like individual action becomes submerged.

The team then sits quiescent, or creeps at a maddeningly slow pace toward its objective—six or ten people with the spirit of cooperation uppermost in mind almost achieving the productivity of any one of them working alone. Eliminate the committee? By no means! The answer lies in the delegation and acceptance of responsibility—individual responsibility.

We need, everyone of us, to reassess the value of those with whom we work, with whom we deal—their value as individuals acting singly, their value as individuals acting as members of a group. The value of the group will take care of itself.

We need to give recognition, within our scope, to the accomplishments of others — individual accomplishments. And if we are to judge others as individuals, to assess the degree to which they accept and discharge their responsibilities, we must also appraise ourselves and our individual performance. This can be a discomfiting project, for pride in one's company, one's society, one's club, can become a bitter pill if there is not also a quiet pride in one's own efforts in that company, that society, that club.

For in each case, it is the efforts of individuals, directed successfully to some specific purpose, that enables one to say: This is a company, this is a great society, this is an agreeable club. As Shakespeare said: "The elements so mixed in him that Nature said 'Here is a man.' "

As our organizations grow, what magnificent successes could result from full individual participation, from the shouldering of maximum responsibility by not just a few, but by every individual member. The goals that could be reached are beyond imagination. And not the least of the results would be the personal satisfaction derived from the full exercise of individual abilities.

This is not idle thoughts of Utopia. It could be accomplished. We who are assembled here, others who are members of the AIC can create the proper atmosphere. We are professional people, we can be leaders beyond the confines of our specific occupations—we can act to accept and discharge individual responsibilities beyond those conventionally implied or specified. We can help to create in our own companies, in our own departments, the atmosphere, the climate in which our associates will be stimulated to performance at the highest possible level.

We can act to see that the opportunity to accept individual responsibility is made available to those with whom we associate. We can act, not only by word, but by deed to reaffirm the importance of the individual in the group. Do not disparage the team, but do maintain the awareness that it is a collection of individuals.

To reinforce the idea of individual action and participation, let me make one final point—the AIC will never contribute to the betterment of human welfare—its members, acting in concert can and will, immeasureably.

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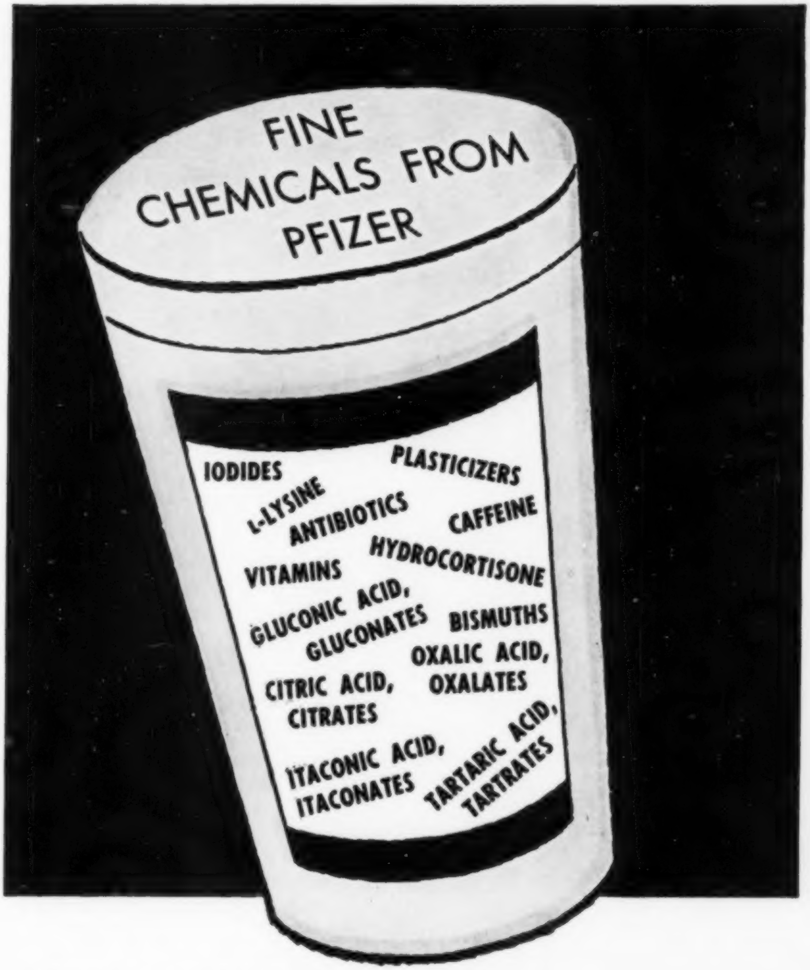
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